MSA MATERIALS SCIENCE ASSOCIATES, LLC

315 Commerce Park Road, Unit 4, North Kingston RI 02852 Tel (401) 290-8823 Fax (401) 667-0993

Medical Science, Engineering, Computer, Software and Image Analysis 1(800) MSA-MSA1

February 28, 2013

Subject: 3D analysis of 2010 Tighar Nikumaroro ROV Video

I, Fatih Calakli of Materials Science Associates, performed video and 3D image analysis of the 2010 Tighar Nikumaroro ROV Video using a 1920x1080 HD copy of the video footage. The purpose of the analysis was to provide composite and 3D image reconstructions to allow our team to compare the videos to 3D engineering models of plane assemblies from Amelia Earhart's Lockheed Electra Model 10. I am a qualified and experience Software, Electrical and Computer Engineer. A copy of my cv is attached to this report.

Figure 1, 2a and 2b shows composite images of the ocean floor, each of which is acquired by combining several still images from the 2010 TIGHAR 1920x1080 video using *Auto-Stitch*[1] algorithm. The algorithm first extracts and matches local features between all still images, so the overlapping regions between images are detected. The detected regions are then used to compute 2D perspective image transformations, so every image is brought into a common magnification as if they were taken from a single perspective. Finally, they are combined by overlaying one onto another. Figure 3 is a scaled stitch composite from 64 images showing debris field from the TIGHAR 2010 Nikumaroro video (1920x1080).

Figure 4 and 5 shows 3D reconstructions of the trajectory of the 2010 TIGHAR 1920x1080 video camera over the ocean floor (depicted as triangle cloud) along with the structure of the ocean floor (depicted as sparse point cloud). These results are acquired by processing several still images viewing the ocean floor from different positions with *Visual Structure From Motion*

EXHIBIT G

[1] Brown, M., & Lowe, D. G. (2007). Automatic panoramic image stitching using invariant features. International Journal of Computer Vision, 74(1), 59-73.

System (VisualSFM)[2] software based on *Photo-Tourism*[3] algorithm. The algorithm first extracts point correspondences between all images, so images with overlapping regions are discovered. The measured correspondences between matching images are then used to fit a pin-hole[4] camera model, so the camera pose and orientation for each image is recovered.

Figure 6 shows 3D reconstruction of the structure of the ocean floor (depicted as dense point cloud). This result is acquired by processing several still images from the 2010 TIGHAR 1920x1080 video and the trajectory of the rover camera with *Patch Based Multi View Stereo (PMVS)*[5] software based on M*ultiview-Stereopsis*[6] algorithm. The algorithm matches and reconstructs local features to estimate a sparse 3D structure of the scene. The algorithm then iteratively expands matches to nearby locations visible in the images, so the density of reconstructed structure is increased.

[2] Visual Structure from Motion System (http://ccwu.me/vsfm/)
[3] Snavely, N., Seitz, S. M., & Szeliski, R. (2006). Photo tourism: exploring photo collections in 3D. *ACM transactions on graphics (TOG)*, *25*(3), 835-846.
[4] Hartley, R., & Zisserman, A. (2003). *Multiple view geometry in computer vision*. Cambridge university press.
[5] Patch-based Multi-view Stereo Software (http://www.di.ens.fr/pmvs/)

[6] Furukawa, Y., & Ponce, J. (2010). Accurate, dense, and robust multiview stereopsis. Pattern Analysis and Machine Intelligence, IEEE Transactions on,32(8), 1362-1376.

Conclusions

I offer the following opinions to a reasonable degree of scientific certainty and in accordance with accepted methodologies and principles in my fields of study:

1) The composite images created from the videos were made using current and accepted methods in the field of image processing and computer vision.

2) The position and location of the video cameras was calculated using current and accepted methods in the field of computer vision and computer graphics.

3) The sparse and dense 3D point clouds were created using current and accepted methods in the field of computer vision and computer graphics.

Sincerely,
Materials Science Associates, LLC

Fatih Calakli, MSc
Software, Electrical and Computer Engineer

Figure 1 Composite image acquired by combining 8 still images selected from the TIGHAR 2010 Nikumaroro video (1920x1080).

Figure 2a Composite image acquired by combining 32 still images selected from the TIGHAR 2010 Nikumaroro video (1920x1080)

Figure 2b Composite image acquired by combining 4 still images selected from the TIGHAR 2010 Nikumaroro video (1920x1080)

Figure 3 Scaled stitch composite from 64 images showing debris field from the TIGHAR 2010 Nikumaroro video (1920x1080).

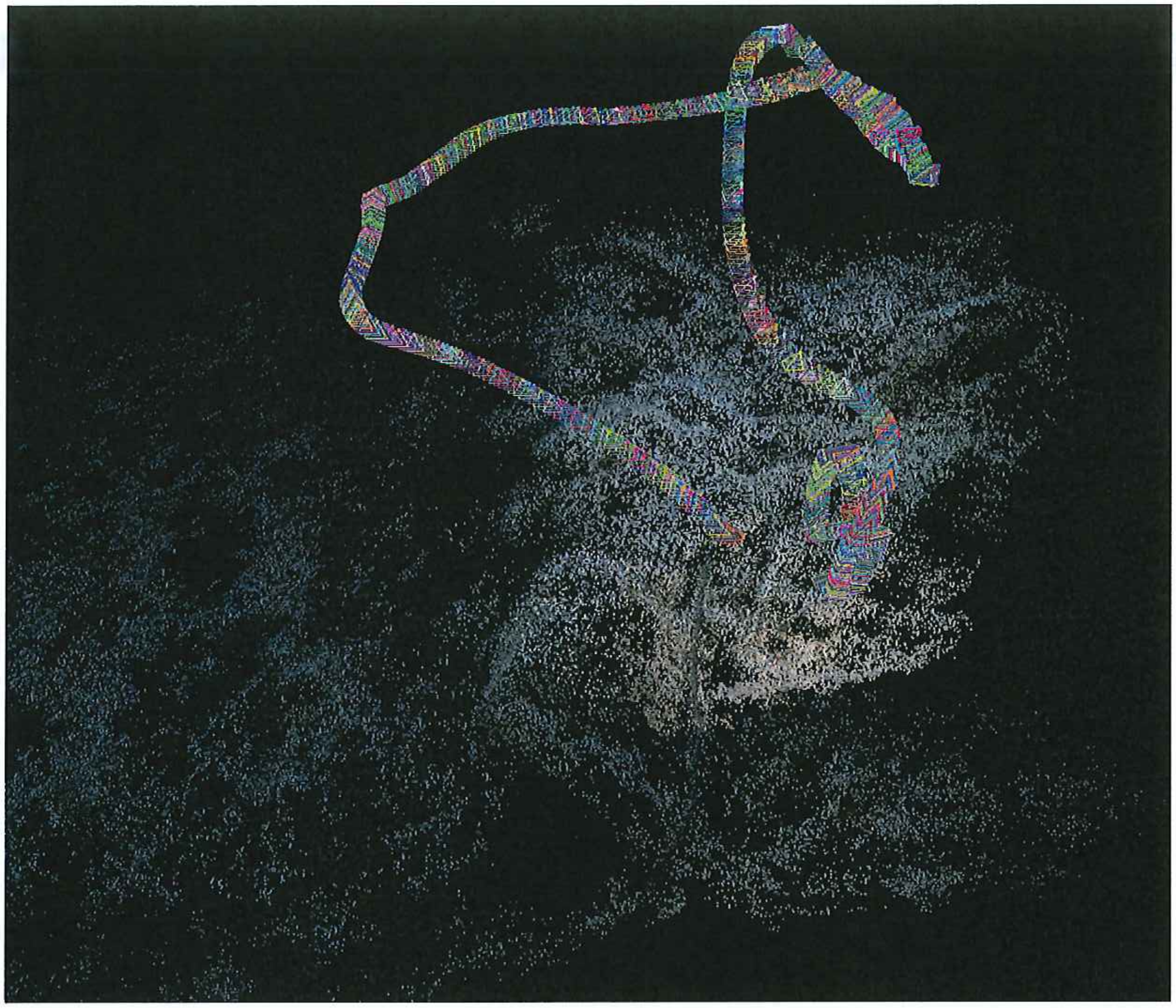

Figure 4 The rover camera trajectory (depicted as triangle cloud) over the ocean floor (depicted as sparse point cloud) acquired by analysing the TIGHAR 2010 Nikumaroro video (1920x1080).

Figure 5 The rover camera trajectory (depicted as triangle cloud) over the ocean floor (depicted as sparse point cloud) acquired by analysing the TIGHAR 2010 Nikumaroro video (1920x1080).

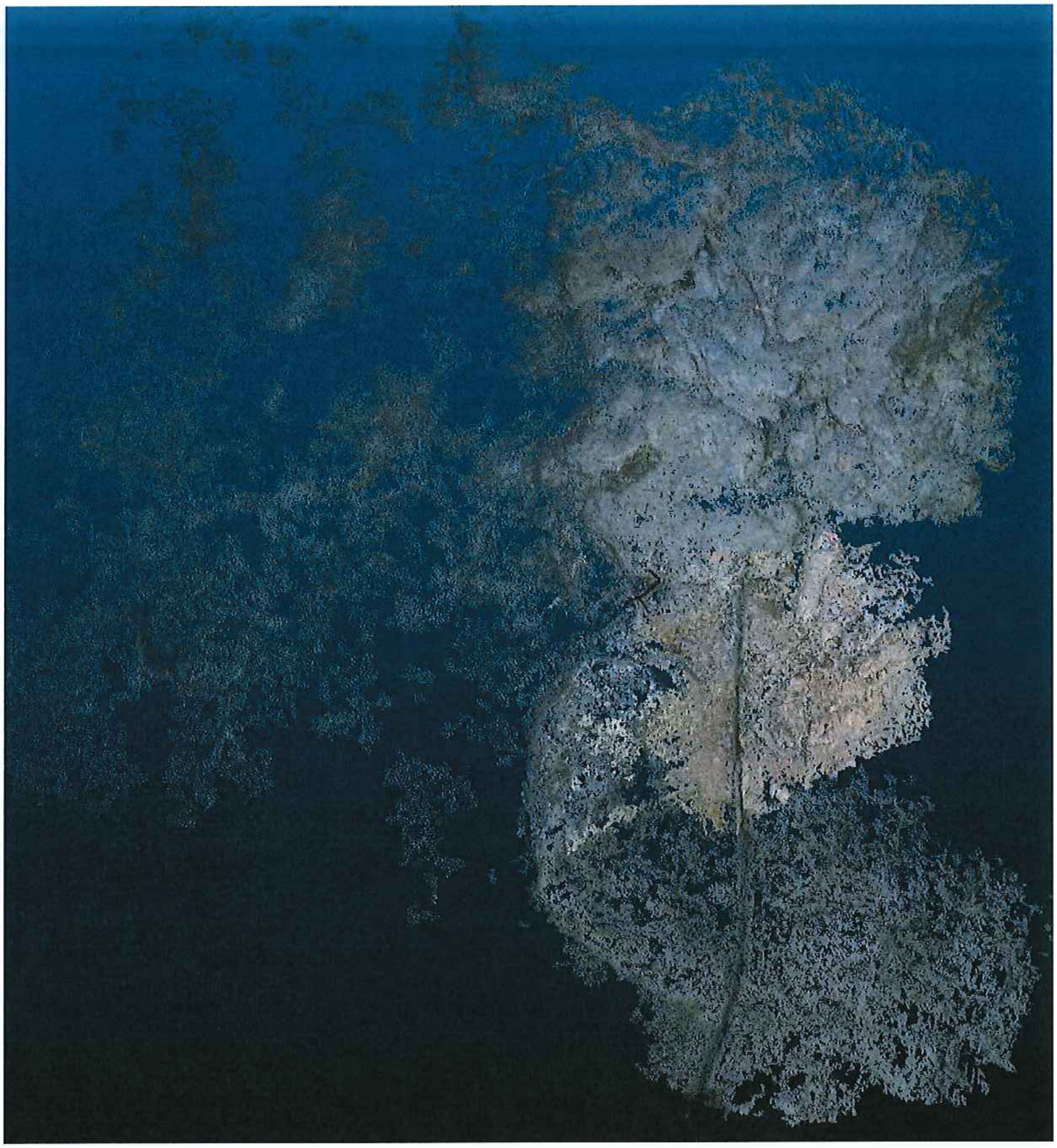

Figure 6 Dense 3D reconstruction of the structure of the ocean floor acquired by processing 900 images selected from the TIGHAR 2010 Nikumaroro video (1920x1080).